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COMMENTARY ON INDIAN STANDARD SCHEDULES FOR WROUGHT STEELS

PART 2 CARBON STEELS (UNALLOYED STEELS) [COMPLEMENTARY TO IS : 1570 (PART 2)-1979]

(First Revision)

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PART 2 CARBON STEELS (UNALLOYED STEELS) [COMPLEMENTARY TO IS : 1570 (PART 2)-1979]

(First Revision)

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COMMENTARY ON INDIAN STANDARD SCHEDULES FOR WROUGHT STEELS

PART 2 CARBON STEELS (UNALLOYED STEELS) [COMPLEMENTARY TO IS : 1570 (PART 2)-1979]

(*First Revision*)

0. FOREWORD

0.1 This Indian Standard (Part 2) (First Revision) was adopted by the Bureau of Indian Standards on 25 May 1987, after the draft finalized by the Alloy Steels and Special Steels Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Commentary on Indian Standard wrought steels for general engineering purposes was first published in 1965 as complementary to IS : 1570-1961*.

0.3 With the revision of IS : 1570 into different parts, it was felt necessary to revise IS : 1871-1965†.

0.4 The following major modifications have been made in this revision.

a) Steel designations has been modified in accordance with IS : 1762 (Part 1)-1974‡. However, for the sake of easy identification, old designations are also given within brackets.

b) The various grades deleted or added in the revision of IS : 1570 (Part 2)-1978§ have been taken care of.

0.5 This part covers carbon steels with specified chemical composition and related mechanical properties.

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*Commentary on Indian Standard schedules for wrought steels for general engineering purposes.

†Schedules for wrought steels for general engineering purposes.

‡Code for designation of steels: Part 1 Based on letter symbols (*first revision*).

§Schedules for wrought steels: Part 2 Carbon steels (unalloyed steels).

0.6 Other parts in this series are as follows:

a) Steels specified by tensile and/or yield properties,

b) Carbon and carbon-manganese free cutting steels,

c) Alloy steels including carbon steels for hardening and tempering and case hardening,

d) High alloy steels and stainless and heat resisting steels including valve steels,

e) Carbon and alloy tool steels, and

f) Creep resisting steels.

1. SCOPE

1.1 This commentary (Part 2) covers carbon steels with specified chemical composition and related mechanical properties.

1.1.1 The chemical composition of these steels is given in Table 1.

1.1.2 Typical uses of the steels covered is this part are given in Appendix A.

2.0 For certain purposes, steels are produced to specific compositions. For carbon steels, ranges for carbon and manganese are laid down. Where necessary, for steels of low carbon content, the silicon content or the type of steel (killed, semi-killed or rimmed) is specified. The limits of sulphur and phosphorus are stipulated depending on service requirements.

2.1 Steels in Hot Worked and Normalized Condition — Steels, having up to 0·60 percent carbon, are generally used in hot worked or nomalized condition and steels with carbon content more than 0·60 percent are used in normalized and tempered or annealed condition for better machinability and improved mechanical properties. The tensile properties of these steels in the hot worked or normalized condition are given in Table 2 of IS : 1570 (Part 2)-1979.

2.1.1 Hot working involves rolling, forging or extrusion of steel at elevated temperatures; the temperatures employed vary with the composition of steel. The plastic deformation takes place at temperatures and at rates that do not cause strain hardening.

TABLE 1 SPECIFIED CARBON AND MANGANESE LIMITS FOR STANDARD STEELS

(*Clause* 1.1.1)

Steel Designation [*See* IS : 1762 (Part 1)-1974]		*C* Percent	Mn Percent
New	Old		
(1)	(2)	(3)	(4)
2C2	(—)	0·05 *Max*	0·40 *Max*
4C2	(C04)	0·08 *Max*	0·40 *Max*
5C4	(C05)	0·10 *Max*	0·50 *Max*
7C4	(C07)	0·12 *Max*	0·50 *Max*
10C4	(C10)	9·15 *Max*	0·30-0·60
14C4	(C14)	0·10-0·18	0·40-0·70
15C4	(C15)	0·20 *Max*	0·30-0·60
15C8	(C15Mn75)	0·10-0·20	0·60-0·90
20C8	(C20)	0·15-0·25	0·60-0·90
25C4	(C25)	0·20-0·30	0·30-0·60
25C8	(C25Mn75)	0·20-0·30	0·60-0·90
30C8	(C30)	0·25-0·35	0·60-0·90
35C4	(C35)	0·30-0·40	0·30-0·60
35C8	(C35Mn75)	0·30-0·40	0·60-0·90
40C8	(C40)	0·35-0·45	0·60-0·90
45C8	(C45)	0·40-0·50	0·60-0·90
50C4	(—)	0·45-0·55	0·30-0·60
50C8	(C50)	0·45-0·55	0·60-0·90
50C12	(C50Mn1)	0·45-0·55	1·10-1·40
55C4	(C55)	0·50-0·60	0·30-0·60
55C8	(C55Mn75)	0·50-0·60	0·60-0·90
60C4	(—)	0·55-0·65	0·30-0·60
60C6	(C60)	0·55-0·65	0·50-0·80
65C6	(C65)	0·60-0·70	0·50-0·80
70C6	(C70)	0·65-0·75	0·50-0·80
75C6	(C75)	0·70-0·80	0·50-0·80
80C6	(C80)	0·75-0·85	0·50-0·80
85C6	(C85)	0·80-0·90	0·50-0·80
98C6	(C98)	0·90-1·05	0·50-0·80
113C6	(C113)	1·05-1·20	0·50-0·80

2.1.2 Normalizing consists of heating steel above its critical temperature and subsequent cooling in air. Normalizing refines and makes the grains more unifrom with subsequent improvement in mechanical properties. It is especially beneficial for bars rolled at low temperatures and in case of rolled or forged products of bigger section sizes.

2.1.3 Tempering relieves the internal stresses in heavy section and may spheroidized the carbides depending upon the time and temperature of the operation. Annealing relieves the stresses developed during working and improves the ductility. In high carbon steels, similar to tempering, it spheroidized the carbides making the steel better machinable.

2.2 Cold Worked Steels — Cold working involves changes in the structure of steel by grain distortion and is accompanied by changes in the mechanical properties due to strain hardening. When applied to bars, tubes, sheets, strips and wire, it is the process of reducing the cross-sectional area by cold rolling, cold drawing or cold extrusion. Cold working is employed to obtain in steel improved mechanical properties, better machinability, size accuracy, bright surface, and for the production of thin gauges.

2.2.1 The overall effect of cold work on steel is to increase its strength and hardness, and decrease its ductility. If cold working is carried out in one direction only, as in cold rolling of sheets or cold drawing of bars or wire, the cold worked steel gets stronger in the direction of working than at right angles to it.

2.2.2 Table 3 of IS : 1570 (Part 2) - 1979* enumerates the tensile properties of some of the steels in the cold drawn condition.

2.2.3 Since cold drawing progressively work hardens steel, many grades, particularly high carbon require one or more annealing treatments during the sequence of reductions to the final gauge. As a large proportion of sheet and strip is required with maximum softness and ductility, it is necessary to give an annealing, or in some cases, normalizing treatment to cold rolled sheet and strip in final sizes. However, sometimes, a certain degree of cold working effect is required in the material to be delivered. In such cases, the reduction applied in the final stages of cold rolling has to be carefully controlled to produce the required hardness and strength.

2.2.3.1 Some steels in the annealed condition, on subsequent forming and pressing, are liable to develop kinks and stretcher strain marking on the surface due to yield phenomenon occurring in such steels. In such cases, the sheets and strips are given a very light cold pass after final annealing. It has negligible effect on the thickness but reduces aging tendency of the steel and improves the surface quality. This final cold pass is known as skin passing.

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*Schedules for wrought steels : Part 2 Carbon steels (unalloyed steels).

2.2.3.2 The yielding in steel is mostly attributed to some interstitial atoms like carbon and nitrogen which anchor the dislocations and resists their movements. At certain stress level, the dislocations get released and yielding occurs in the steel. Many varieties of aluminium killed low carbon steels are available for deep drawing applications. Boron treated semi-killed varieties have also been developed and are available for certain applications. Aluminium and boron combine with nitrogen to form respective nitrides and make the steel non-aging type.

2.2.3.3 When maximum ductility for very severe drawing and pressing operations are required, steels 4C2, 5C2 and 7C4 are often specified.

2.2.3.4 For less severe cold working, steels 10C4 and 15C4 are used. Their properties are given in Table 1 of IS : 1570 (Part 2)-1979*. Steel 15C4 is often used cold rolled to varying degrees of hardness or temper as included in Table 7 of IS : 1570 (Part 2)-1979*. Considerable quantities of cold rolled strips are required for small flat section springs and steels 50C4, 50C12, 55C4, 55C8, 60C6, 70C6, 80C6, 98C6 and 113C6 are supplied in the annealed or cold rolled condition for this purpose. The choice of steel depends on the degree of forming and bending involved in making the spring, the size of the section and the severity of duty of the spring. Cold rolled sheet and strip are made from low alloy steel.

2.2.4 Hot finished tubes, depending on the size requirements, are also further modified dimensionally by cold drawing or rolling. Cold drawn tubes provide smaller diameters and thinner wall, and possess better surface and greater dimensional accuracy; in the case of welded tubes, welding fins are also eliminated. Table 8 of IS : 1570 (Part 2)-1979* specify the expected properties of steel tubes in the cold drawn or cold drawn and tempered condition.

2.2.5 In steel wire, high strengths are obtained by cold drawing rod or wire after appropriate heat treatment from a predetermined size to the required diameter. The tensile strengths obtainable in different carbon steels with different percentages of reduction during cold drawing are given in Fig. 1.

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*Schedules for wrought steels : Part 2 Carbon steels (unalloyed steels).

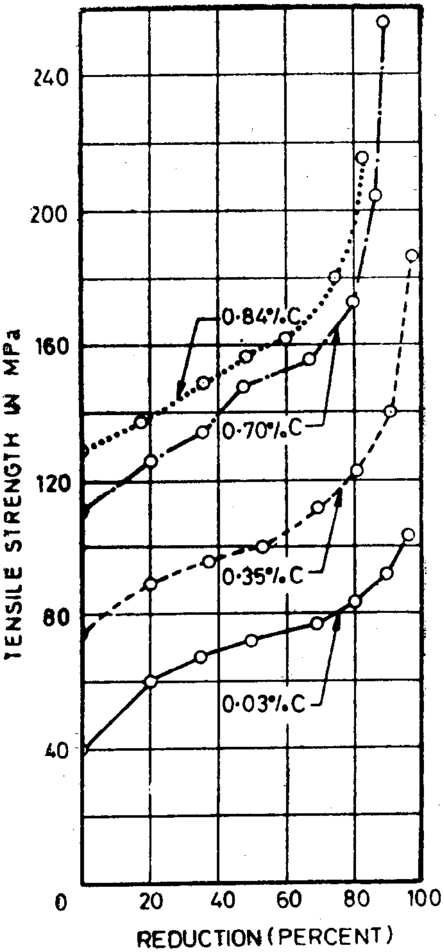

FIG. 1 EFFECT OF DRAWING ON THE TENSILE STRENGTH OF CARBON STEEL WIRE

2.2.5.1 To impove drawing quality and to meet the special requirements of mechanical properties, steel is heat-treated in the form of rod. The quality of steel is also vital. The fabrication of wire and service requirements determine the steel making process to be used.

2.3 Carbon steels (carbon 0·25 to 0·60) may also be used in the hardened and tempered condition. For details reference may be made to Part IV of this series where these steels have been discussed along with alloy steels for hardening and tempering.

APPENDIX A

(*Clause* 1.1.2)

TYPICAL USES OF INDIAN STANDARD STEELS/CARBON STEELS WITH SPECIFIED CHEMICAL COMPOSITION AND RELATED MECHANICAL PROPERTIES

Steel Designation	*Typical Uses*
4C2	Dead soft steel generally used in electrical industry.
5C4, 7C4, 10C4	Used where cold formability is the primary requirement. In the rimming quality, they are used as sheet, strip, rod and wire specially where excellent surface finish or good drawing qualities are required, such as automobile body and fender stock, hoods, lamps, oil pans, and a multiple of deep drawn and formed products. They are also used for cold heading wire and rivets, and low carbon wire products. Killed still is used for forging and heat treating applications.
10C4, 14C6	Case hardening steels used for making camshafts, cams, light duty gears, worms, gudgeon pins, selector forks, spindles, pawls, ratchets, chain wheels, tappets, etc.
15C4	Used for lightly stressed parts. The material, although easily machinable, is not designed specifically for rapid cutting, but is suitable where cold web, such as bending and riveting may be necessary.

Steel Designation	*Typical Uses*
15C8, 20C8, 25C4, 25C8	General purpose steels for low stressed components.
30C8	Used for making certain types of cold formed parts, such as shift and brake levers. After suitable case hardening or hardening and tempering, this steel is also made use of in making parts, such as socket, tie rod, yolk adjustable control lever cable, shaft fork and rear hub, 2-wheeler and 3-wheeler parts, such as sprocket, lever, hubs for forks, cams, rocker arms and bushes are made of this steel. Tubes for aircraft, automobile, bicycle and furniture are also made of this steel.
35C4	Steel for low stressed parts, automobile tubes and fasteners.
35C8	Steel for making low stressed parts in machine structures cycle and motorcycle chassis tubes, fish plates for rails and fasteners.
40C8	Steel for crankshafts, shafts, spindles, automobile axle beams, push rods, connecting rods, studs, bolts, lightly stressed gears, chain parts, umbrella ribs, washer, etc.
45C8	Steel for spindles of machine tools, gears, bolts lead screws, feedreds, shafts and rocks.
50C4	Steel for making keys, shafts, cylinders, machine components requiring moderate wear resistance. In surface hardened condition, it is also suitable for large pitch worms and gears.
50C8	Rail steel. Also used for making spike bolts, gear shafts, rocking levers and cylinder liners.
55C4, 55C8	Steels used for making gears, cylinders, cams, keys, crank shafts, sprockets and machine parts requiring moderate wear resistance for which toughness is not of primary importance, cycle and industrial chains, spring, safety books parts, can opener, thompson blade, umbrella ribs, parts of camera and typewriter.

Steel Designation	*Typical Uses*
60C4	Steel for making spindles for machine tools, hardened screws and nuts, couplings, crank shafts, axles and pinions.
65C6	High tensile structural steel for making locomotive carriage and wagon tyres. Typical uses of this steel in the spring industry include engine valve springs, small washers and thin stamped parts.
70C6	Steel for making baffle springs, shock absorbers, springs for seat cushions for road vehicles. It is also used for making rail tyres, unhardened gears and worms, washer, wood working saw, spring, ampoule cutters, textile and jute machinery parts.
75C6	Steel for making light flat springs formed from annealed stock. Because of good wear properties, when properly heat treated, it is used for making plough shears, rake teeth, scrappers and cultivators' shovels.
80C6, 85C6	Steels for making flat and coil springs for automobiles and railway vehicles. Also used as girder rails. Valve spring wire and music wire are special applications of steel C85. After suitable heat treatment, these steels are also used for making scraper blades, discs and spring tooth harrows. Clutch parts, spring, wood working saw, band saw, textile and jute machinery parts.
98C6 and 113C6	In the oil-hardened and tempered condition used for coil or spiral springs, pen nib, volute spring, gauge, spring cutlery, knitting needle, hacksaw blades.

(*Continued from page* 2)

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